

SMATV **PLANNING**

**Quality Reception from
your Satellite Dish to
multiple receivers**

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THE BASIC PROBLEM:

- ☐ **Satellite Signals are at microwave frequencies**
 - 3.65 to 4.2 Gigahertz (GHz)
 - 10.95 to 12.75 Gigahertz
- ☐ **Satellite signals are transmitted in non-compatible modulation formats**
 - Wideband FM (17 to 54 Megahertz in width)
 - (Compressed) Digital Video (such as QPSK)

WHEREAS -

- ☐ **'Standard' TV receivers are designed to respond to:**
 - 6 or 7 or 8 Megahertz wide 'channels'
 - With Amplitude Modulation (AM) video, and,
 - Frequency Modulation (FM) audio

THEREFOR-

- ☐ **To receive (recover video and audio) from satellite transmission on 'Standard' TV receiver**
 - The video and audio modulation from the satellite format must be recovered at 'baseband'
 - And, re-introduced through an appropriate 'Standard TV Modulator' to the TV receivers

IT IS NOT ENOUGH TO-

- ☐ **Simply frequency convert the received satellite signals to terrestrial TV channels**
 - A 17 to 54 MHz wide satellite channel will not 'fit' into a 6/7/8 MHz wide terrestrial channel
 - A TV receiver designed to 'recover' AM video will not respond (detect) FM video

BANDWIDTH vs. FORMAT

Standard (Terrestrial) TV channel: 6, 7, or 8 MHz wide

Satellite in 1/2 transponder format; approximately 17 MHz wide

Satellite in 36 MHz wide format

Satellite in 54 MHz wide format

'Lower' TV signal: 27 MHz wide

'Upper' TV signal: 27 MHz wide

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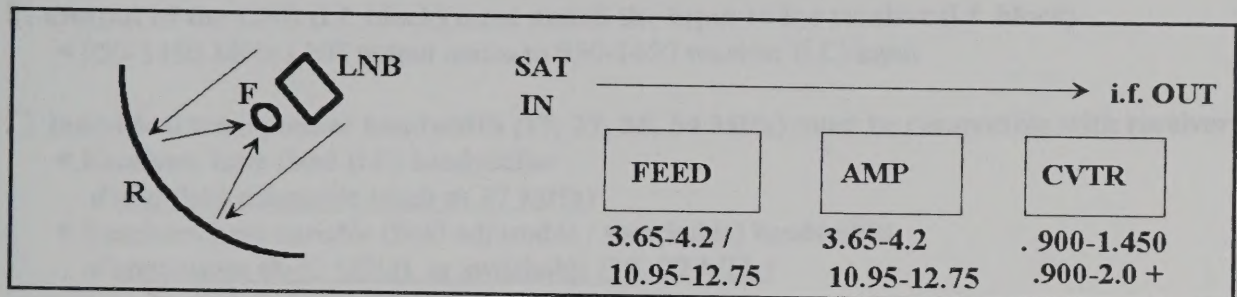
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BASICS FIRST-

☐ A satellite signal is first:

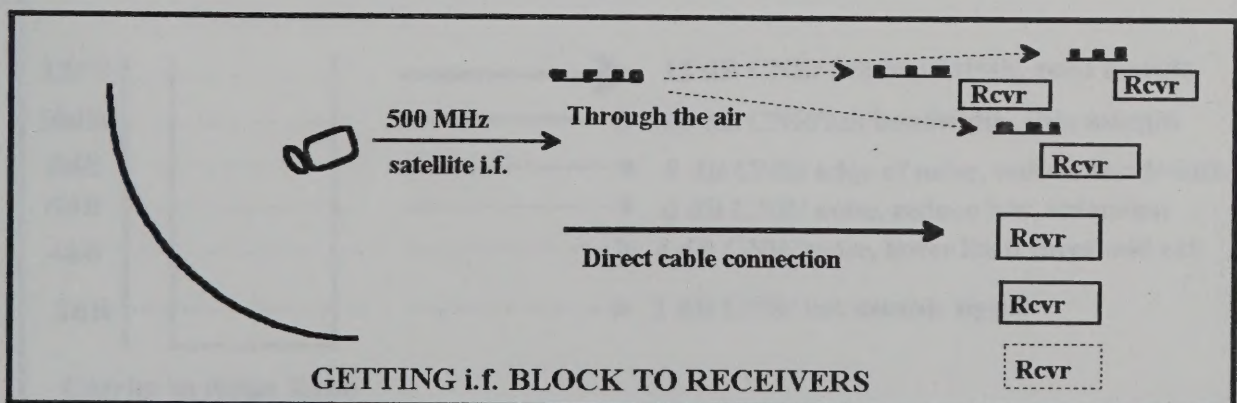
- Taken off the reflector's surface with a feed antenna
- Amplified at it's incoming frequency (3.65-4.2 GHz; 10.95-12.75 GHz)
- Down converted (frequency translated) to a convenient ('standard') i.f.



- ☐ All satellite signals leave LNB at i.f. (intermediate frequency) as a 'block' of frequencies
- Bandwidth of 'block' is identical to bandwidth of incoming satellite band
 - A 500 MHz (0.5 GHz) wide satellite band requires an i.f. of 500 MHz also
- ☐ When satellite(s) utilise a bandwidth greater than 500 MHz, receiver must also be wider
- Multiple satellites at Ku may use frequency blocks within 10.95-12.75 GHz region
 - Receivers must somehow adapt to a spectrum that is wider than 'standard' 500 MHz
 - ✓ Receiver i.f. can be widened to 900-2,100 MHz (total width of 1,200 MHz)
 - ✓ LNB can be 'toggled' by switching voltage/tone to treat each block as a separate function
 - 10.95-11.45 GHz, 11.45-11.95 GHz, 11.95-12.45 GHz, 12.25-12.75 GHz
 - 10.95-12.15 GHz, 11.55-12.75 GHz

IN THEORY-

- ☐ You may 'distribute' the i.f. 'block' to your actual receivers via coaxial cable, or,
- ☐ You may transmit the 'block' through the air (wireless) to one or more remote receivers

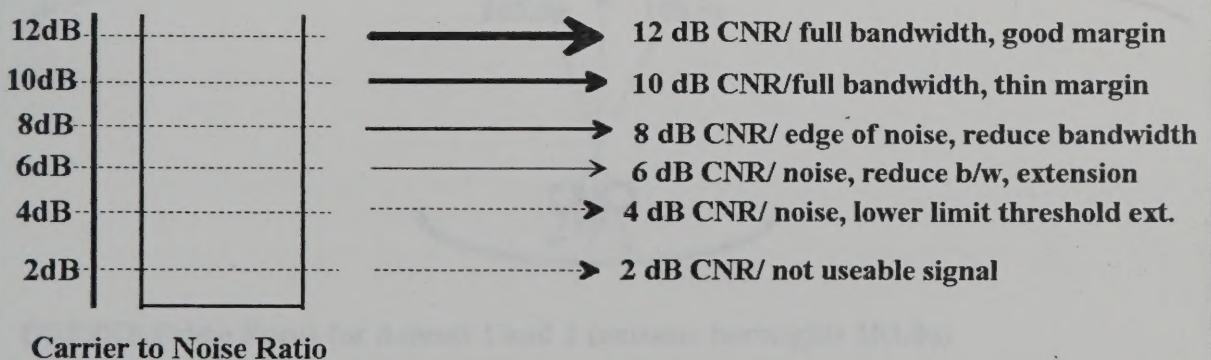


RECEIVERS-

- ☐ Attempt to standardise i.f. (input) ranges
 - Any satellite signal appearing within receiver i.f. block can (in theory) be processed
 - ✓ C or Ku band is not important to receiver demodulator (s)
- ☐ Output of the LNB (i.f. block) must match the input to the receiver (i.f. block)
 - 950-1450 MHz LNB output mates to 950-1450 receiver (i.f.) input
- ☐ Individual transponder bandwidth (17, 27, 36, 54 MHz) must be compatible with receiver
 - Receivers have fixed (i.f.) bandwidths
 - ✓ non-field-adjustable (such as 27 MHz)
 - Receivers have variable (field adjustable / switchable) bandwidths
 - ✓ continuous (8-32 MHz), or switchable (18, 27 MHz)
- ☐ A weak (below receiver threshold) receiver may produce more pleasing pictures if:
 - Bandwidth of receiver is narrowed (below actual satellite signal bandwidth)
 - (if) user is willing to accept reduced bandwidth artifacts (colour ringing, audio buzz)
 - ✓ Threshold extension systems improve receiver 'threshold' but add artifacts

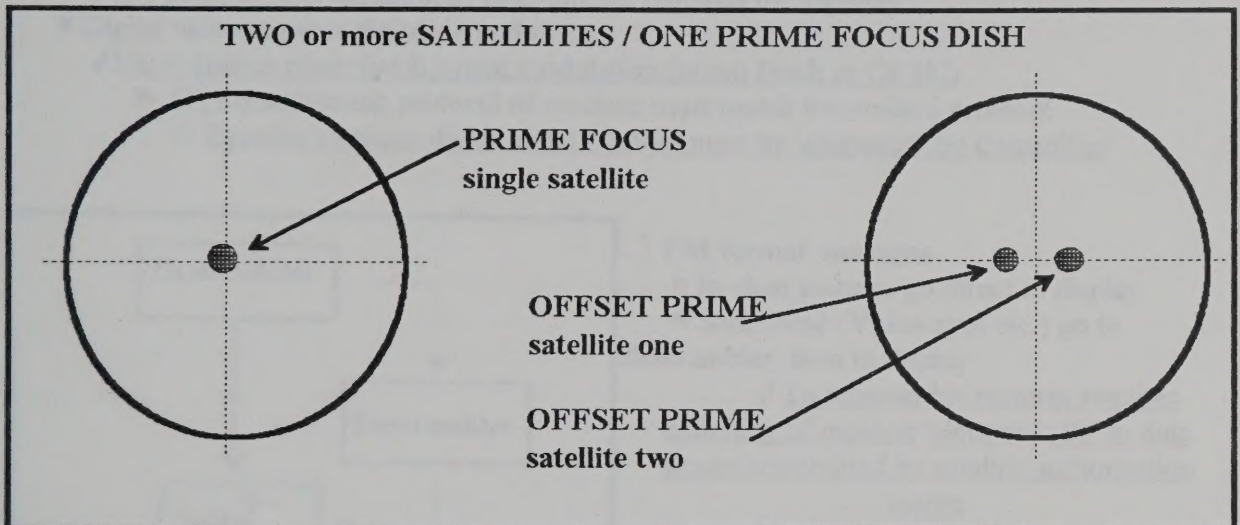
RULE OF THUMB-

- ☐ A satellite channel that is 'below threshold' (sparklies) when receiver matches transmitted b/w:
 - If 'improved' by narrowing bandwidth below transmitted bandwidth, or,
 - (if 'improved') by using threshold extension techniques - probably needs a bigger antenna
- ☐ Signals 'below threshold' and 'electronically altered' to improve apparent quality:
 - Contain undesirable artifacts AFTER processing which magnify in SMATV/CATV system
 - May be subject to undesirable 'weather outages' when rain increases attenuation



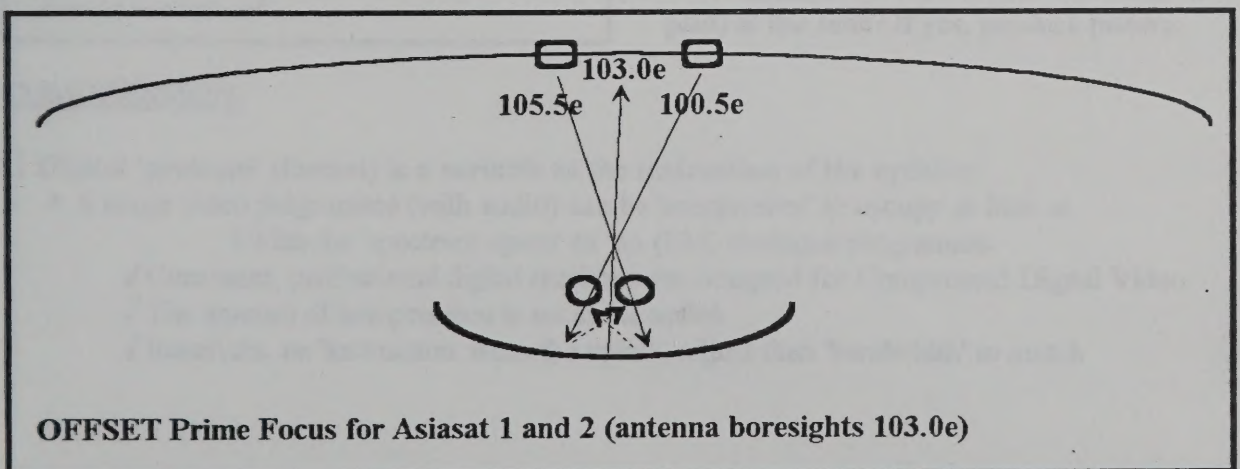
SHARED REFLECTOR / MULTIPLE FEEDS-

- ☐ A prime-focus reflector (requiring feed at centre focus 'spot') may:
 - Have it's prime-focus feed moved away from (offset from) centre, at reduced gain
 - Have two (or more) feeds positioned (either side of centre) for two closed-spaced satellites



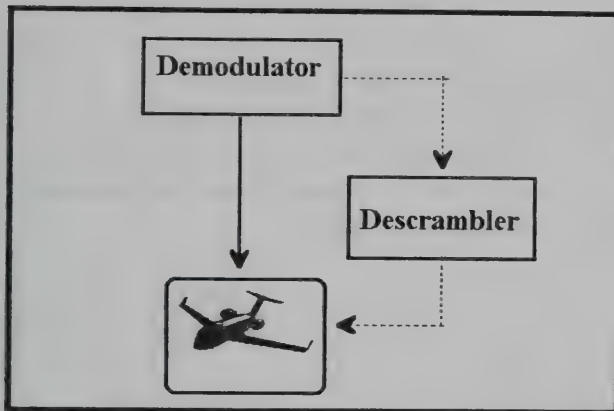
- With 'offset prime' the dish is parked between two satellites; feeds positioned for focus
 - ✓ 'Loss' in gain over single feed at prime focus goes up as feed offset increases
 - on 4m dish, 4 degrees between satellites typically equals -3dB
 - by increasing reflector size to compensate (i.e., 3m to 4.5m), one reflector eliminated
- Non-prime-focus reflector designs (i.e., 'banana antenna') reduce offset losses
 - ✓ System planners must weigh costs, space constraints to reach antenna decision

- ☐ Candidates for dual-satellite / single reflector include Asiasat 1 (105.5e), AsiaSat 2 (100.5e)

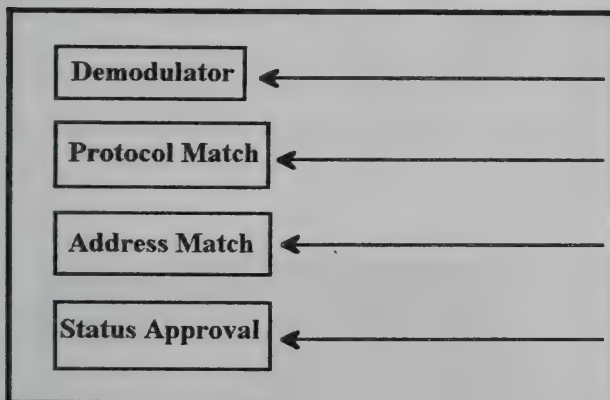


PROCESSING SATELLITE SIGNALS-

- ☐ The satellite receiver demodulator circuit must match modulation format of signal
 - Analogue FM requires FM detector (demodulator)
 - ✓ If transmission is 'in clear' merely tuning receiver produces pictures
 - ✓ If transmission is 'scrambled', descrambler required for 'pictures'
 - Digital video requires digital demodulator
 - ✓ Demodulator must match actual modulation format (such as QPSK)
 - Digital addressing protocol of receiver must match transmitted protocol
 - Receiver's unique digital serial number must be 'addressed' by transmitter



- ☐ FM format analogue
 - In-clear pictures go direct to display
 - Scrambled (Videocrypt etc.) go to descrambler, then to display
 - ✓ To unscramble pictures requires matching of receiver 'electronic ID' to data stream transmitted by satellite authorisation centre
 - ✓ Each programmer has unique data stream 'code'



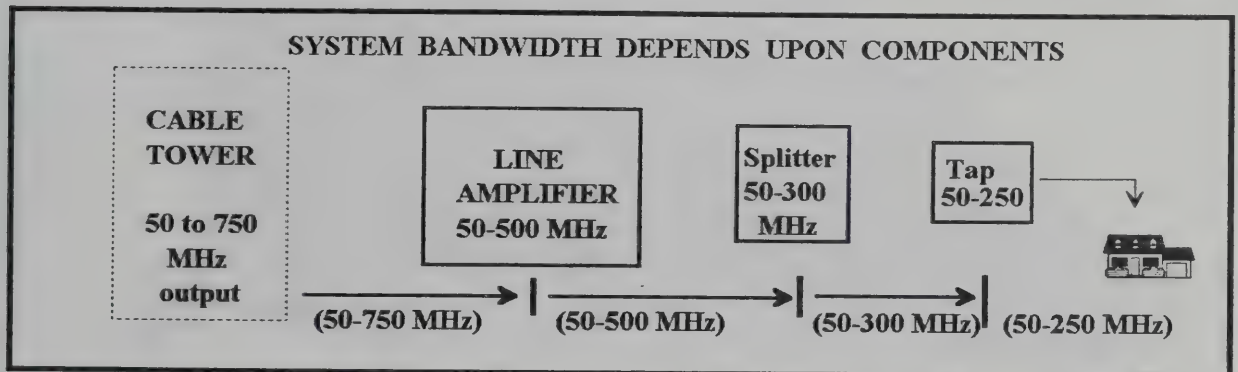
- ☐ Digital Video Access
 - Is signal in digital format? If yes, go on.
 - Is digital video in correct 'format'? If yes...
 - Is THIS receiver being addressed? If yes ...
 - Is THIS receiver's account current (i.e., paid) at this time? If yes, produce picture.

COMPRESSION-

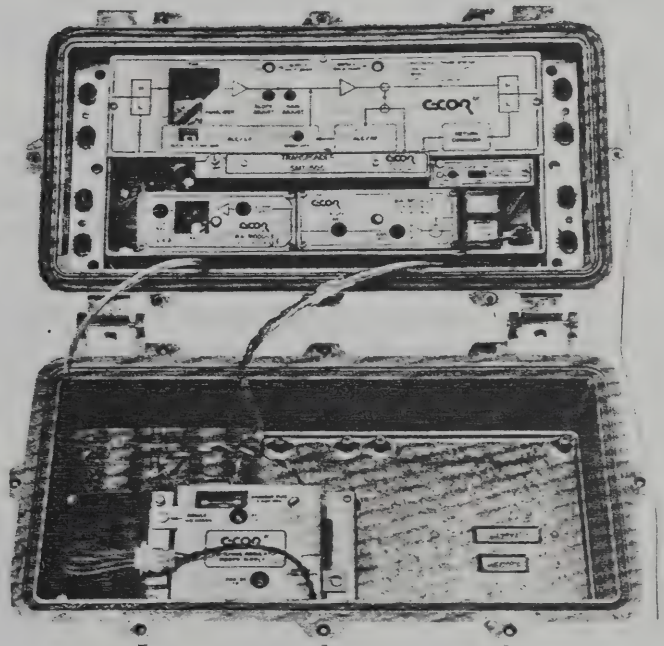
- ☐ Digital 'protocol' (format) is a variable at the instruction of the uplinker
 - A single video programme (with audio) can be 'compressed' to occupy as little as 1/12th the 'spectrum space' of an (FM) analogue programme.
 - ✓ Consumer, professional digital receivers are designed for Compressed Digital Video
 - ✓ The amount of compression is set at the uplink
 - ✓ Receivers, on 'instruction' from the uplink, adjust their 'bandwidth' to match

YOUR SMATV/CATV CABLE SYSTEM-

- ☐ Is a private 'information highway' through which you send signals
- ☐ Has an internal 'bandwidth' established by:
 - The 'passive' distribution cable
 - ✓ Coaxial cable designed to transport VHF-UHF (television) programming is typically 'useable' from 0 MHz (DC) to at least 750 MHz; often 1,000 MHz (1 GHz)
 - The passive components design frequency range
 - ✓ Splitters, tap-off (directional coupler) units, connectors
 - Signal splitters and couplers may be designed for 0-500 MHz or less
 - The active components design frequency range
 - ✓ All amplifier devices have 'gain-bandpass' specifications
 - Gains are stated in dB(s)
 - Bandpass is stated in megahertz (MHz)
 - The 'Cable System Bandwidth' will be no larger than the most frequency-bandwidth limited device installed in the system between the 'tower/antennas' and the 'subscriber's TV set'



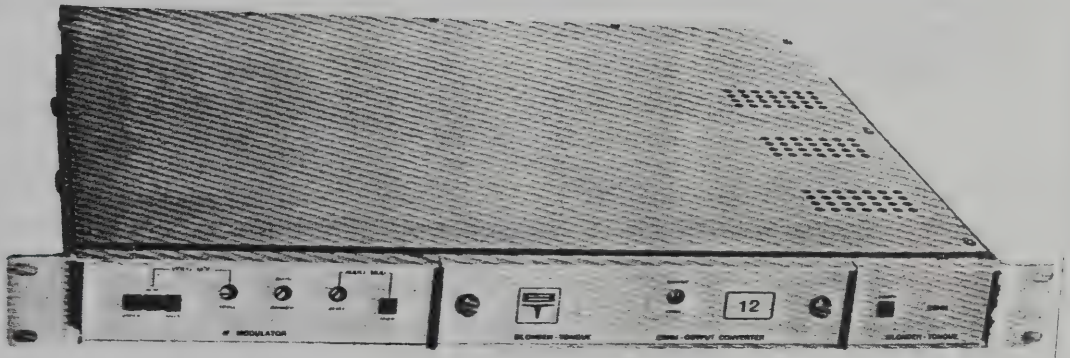
40 to 1,000 MHz Indoor Amp



54 to 550 MHz Outdoor (line) Amp

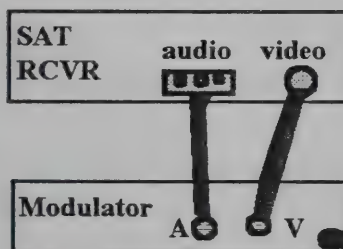
THE HEADEND-

- The SMATV/CATV Headend is a group of low-power 'transmitters' each on a channel
 - Headend Transmitters' are called modulators
 - ✓ Modulators have a specified operating format
 - PAL, NTSC, SECAM
 - Monaural or stereo audio
 - ✓ Modulators have a specified maximum output level
 - +40 to +60 dBmV (+100 to +120 dBuV) is typical
 - ✓ Modulators allow adjustment of video and aural modulation percentages
 - Video modulation is peak-sync limited to avoid overdriving circuits
 - ✓ Modulators are designed for adjacent channel or alternate channel use
 - Spectral purity (limiting transmission products within the channel) determines whether the unit can be used in an adjacent (consecutive) channel format



TYPICAL SMATV/CATV MODULATOR

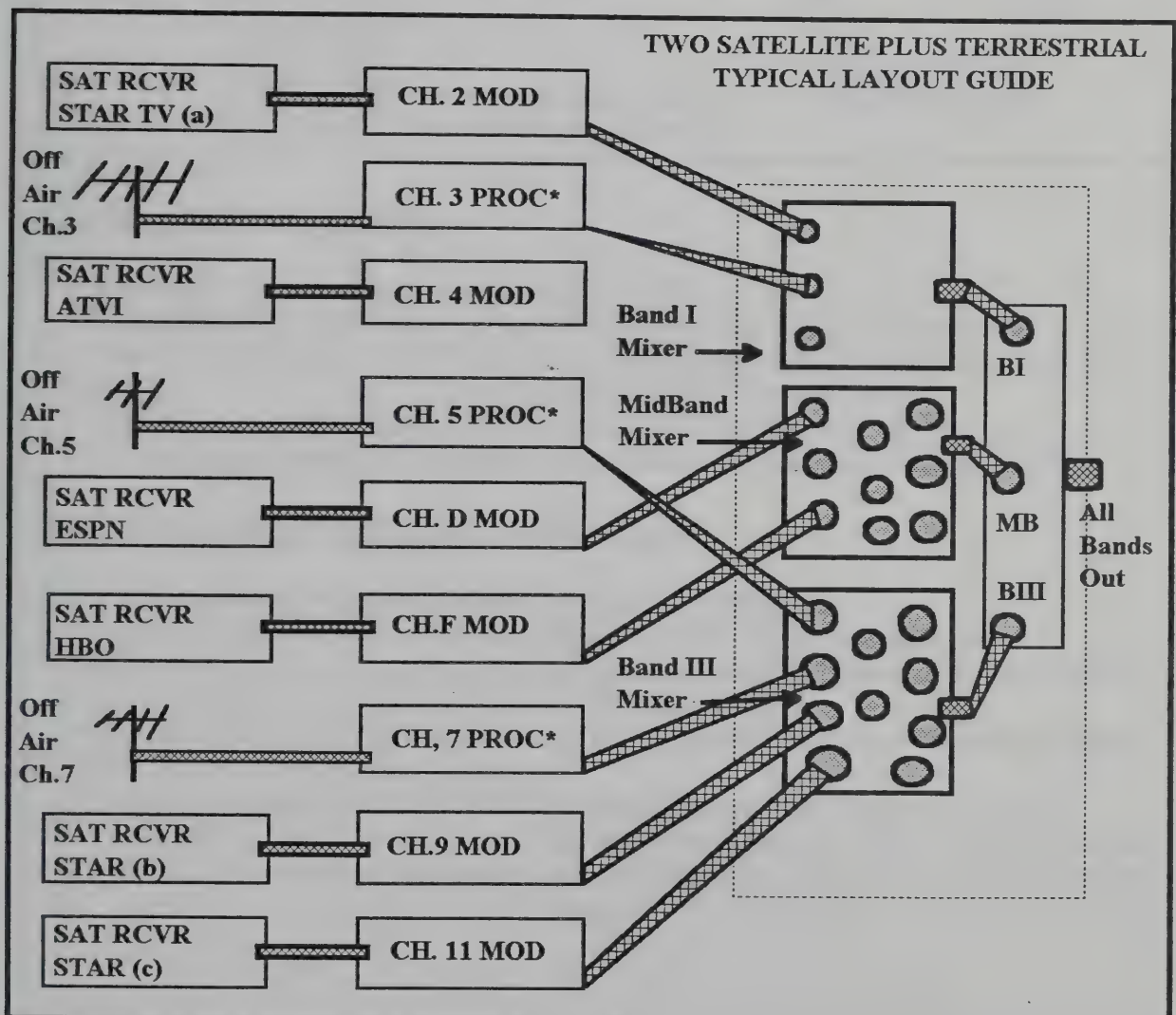
- ✓ Modulators can be fixed-channel (as supplied by the factory), or 'frequency-agile'
 - Frequency agile are field-adjustable through channels (such as 50 to 450 MHz)
- ✓ Modulators are 'fed' baseband video and audio, after the satellite receiver/decoding
 - Well shielded cables are used to connect baseband signals to modulators



SATELLITE RECEIVER FEEDS MODULATOR /
MODULATOR FEEDS SMATV / CATV SYSTEM

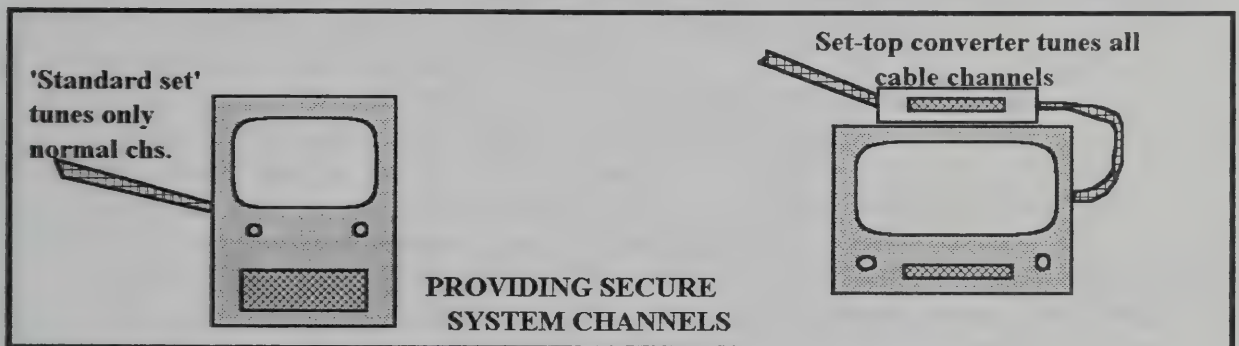
MIXING MODULATORS TOGETHER-

- Two or more channels fed into the cable require 'mixing' of the signal sources
 - Modulators designed for 'adjacent channel' can be 'combined' with a passive network
 - ✓ Passive networks are either:
 - A series of tuned input circuits, each to a specified channel, impedance matched to a broadband output network (a self-contained unit called a 'Headend Combiner')
 - Two or more 'signal splitters', wired up 'backwards' to combine rather than divide signals
 - Use only HYBRID style splitters
 - Two or more 'Directional Couplers' used 'backwards' so the normal output port becomes the modulator signal source port
 - ✓ All passive combining networks have 'thru loss'
 - Thru losses may equal as much as 16 dB between modulator output and final (combined) 'trunk-cable' output
 - Modulator output capability should be chosen after calculating 'combiner losses'



WHAT ABOUT SPECIAL-CHARGE CHANNELS?-

- ☐ Premium channels (HBO, others with higher monthly charge) may be made optionally available
 - You may elect to place these programme-channels on a 'secure frequency'
 - ✓ Any TV channel not easily tuned in on standard TV sets can be 'secure', available only to those who pay 'extra' for service
 - Such channels can also be 'scrambled' for further security
 - TV channels within 'Mid-Band' (108-174 MHz), 'Super-Band' (230-470 MHz) or 'Hyper-Band' (470-750 MHz) may provide you with security
 - ✓ Channels 'outside' of normal TV set tuning ranges can be system-adapted to secure channels with installation of optional subscriber-set-top converter box



AVOIDING SOME CHANNELS-

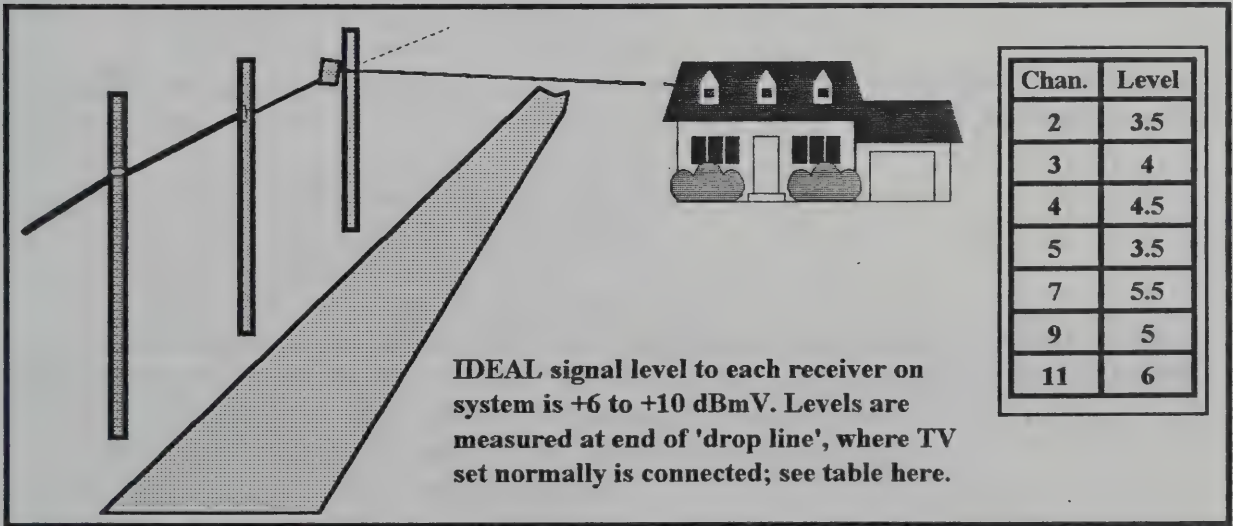
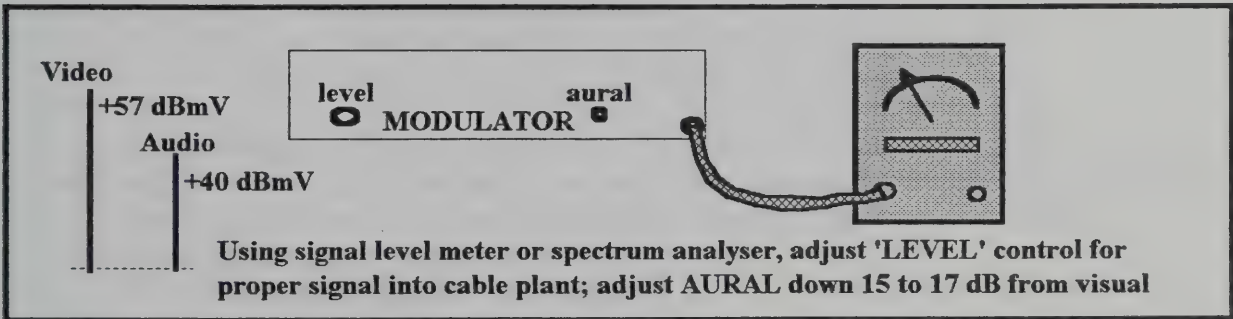
- ☐ In your area, some cable channels may not be useable
 - Avoid placing satellite services on any channel in-used locally for terrestrial TV
 - Avoid any non-standard (mid band, super band, hyper-band) channels used locally for 2-way radio communications
 - ✓ Cable 'ingress' (RF leakage into cable system) can degrade TV service
 - ✓ Cable 'egress' (radiation from cable plant, fittings) can interrupt 2-way services

CONSIDERATIONS FOR SECURE CHANNELS-

- ☐ Any secure channel using non-standard TV frequencies will require:
 - Set-top converter in each home, each location 'taking' secure channel service
 - If channel selection is not adequate security, programming will also need to be 'scrambled'
 - ✓ To descramble at TV set will require set-top descrambler
 - Carefully weigh costs of additional (at TV set) equipment against new revenues possible
 - Any 'security system' invites 'piracy'
 - ✓ If your set-top unit can be obtained in marketplace, you have no security unless:
 - Each set-top descrambler is individually addressable with unique electronic address
 - Your subscriber base justifies investment in complex encoding/addressing system at headend

BASIS FOR CABLE PLANT-

- Coaxial cable 'plant' (the system) is a private, secure transmission system; people only receive service by being connected directly to system
- Coaxial cable has loss
 - ✓ Loss is measured in dBs or parts of dBs per unit length (100 metres) of cable
 - Loss increases (becomes larger) when:
 - The frequency of the signal transported goes up (i.e., 55.25 MHz to 175.25 MHz)
 - The diameter (size), or quality, of cable goes down (i.e., RG-11/U to RG-59/U)
 - The physical temperature of the cable increases (i.e., 20C to 40C)
- Standards establish the ideal, and minimum service levels to subscribers for quality reception
 - The ideal 'range' is +6 dBmV (+66 dBuV) to +10 dBmV (+70 dBuV)
 - The 'minimum' level is 0 dBmV (+60 dBuV)
 - Any two adjacent channel carriers should not be more than 2 dB apart in level
 - ✓ Channel 2 visual carrier: +3.5 dBmV, channel 3 +5.5 dBmV
 - ✓ Channel 7 visual carrier: +7 dBmV, Channel 8 + 9 dBmV
 - The sound carrier for any channel should be 15 to 17 dB lower in level than the video
 - ✓ Headend modulators allow separate level-setting of aural carrier
 - ✓ Headend (off-air signal) Processors allow setting of aural carrier level separate from video
 - Aural carriers are 'set down' to protect upper adjacent video (picture) from sound modulation interference (bars)



PLANNING THE SMATV/CATV SYSTEM-

- Start with accurate, scaled map of area to be cabled. Mark antenna site / headend on map.
 - Whether a single building (motel, apartment house) or community area:
 - ✓ Draw a preliminary system layout on the map to determine places cable will go
 - ✓ Measure and calculate the longest cable run from your headend to most distant receiver
 - ✓ Calculate, using known loss of cables available to you, dB loss in cable from headend through the cable to most distant TV receiver

Cable Type	54 MHz	90 MHz	174 MHz	230 MHz	550 MHz
RG-59/U	5.64	6.68	9.23	10.9	19.42
RG-6/U	4.43	5.26	7.25	8.57	15.28
.500 aluminium	1.35	1.63	2.33	2.79	5.08
.750 aluminium	0.96	1.15	1.63	1.94	3.54

- Losses in table (above) in dB per 100 metres of cable at 20 degrees C for frequency shown
 - A cable plant with 2,000 metres of cable from the headend to the furthest TV receiver:
 - ✓ 2,000m is, from table above, equal to 20 x:
 - 10.9 dB (per 100m) of RG-59/U or 218 dB of cable loss at 230 MHz
 - 8.57 db (per 100m) of RG-6/U or 171.4 dB of cable loss at 230 MHz
 - 2.79 dB (per 100m) of .500 (1/2") or 55.8 dB of cable loss at 230 MHz
 - 1.94 dB (per 100m) of .750 (3/4") of 38.8 dB of cable loss at 230 MHz
 - If our goal is to reach the furthest TV set with a level not less than 0 dBmV (+60 dBuV) at the highest frequency channel on the system (same as maximum cable loss):
 - ✓ We require a headend output of:
 - +218 dBmV if we use RG-59/U cable
 - +171.4 dBmV if we use RG-6/U cable
 - +55.8 dBmV if we use .500 (1/2") cable
 - +38.8 dBmV if we use .750 (3/4") cable
 - Maximum achievable headend output levels are in the region of +60 dBmV (+120 dBuV); therefore to reach the end of a 2,000 metre cable we would require additional gain within the cable plant of:
 - ✓ $218 - 60 = 158$ dBg (gain) for RG-59/U cable
 - ✓ $171.4 - 60 = 111.4$ dBg for RG-6/U cable
 - ✓ $55.8 - 60 = (+) 4.2$ dB with .500 cable
 - ✓ $38.8 - 60 = (+) 21.2$ dB with .750 cable
 - Additional 'plant gain' comes from line amplifiers and 36 dBg (dB of gain) is a practical maximum when multiple amplifiers must be operated in 'series' on the same line (cascade effect)
 - ✓ For RG-59/U this would require 5 amplifiers of 36 dB gain each
 - ✓ For RG-6/U this would require 3 amplifiers of 36 dB gain each
 - ✓ .500 and .750 require no plant amplifiers

NOT ALL 'CABLE PLANT LOSSES' COME FROM CABLE-

- ☐ **Cable plant requires additional passive devices to function, including:**
 - Line splitters (to create two, three, four OUTput legs from one input)
 - 'Directional Couplers', a form of unequal splitter used in certain applications
 - Customer tap-off devices ('directional taps')
 - Connectors, line splices
- ☐ **All passive devices have 'thru-loss'; they reduce the signal level going through them**
 - Line splitters:
 - ✓ 2-way splitter: assume 4 dB 'loss' per output leg
 - ✓ 3-way splitter: assume 5.5 dB 'loss' per output leg
 - ✓ 4-way splitter: assume 7 dB 'loss' per output leg
 - Directional Couplers:
 - ✓ Losses vary from minimum of 1.5 dB per leg upwards as a design function
 - Customer tap-off devices ('Directional Taps'):
 - ✓ Through losses (between line input, line output) of device varies from 0.1 dB to 4.0 dB
 - Connectors, line splices:
 - ✓ Losses average 0.15 dB per connector or 0.3 dB per line splice
- ☐ **Individual item losses of 0.1 or 0.3 dB may seem unimportant, but:**
 - If there are 30 such devices between the headend and the customer, the cumulative total of such 'small losses' could be 3 to 9 dB
 - 'Dynamic Plant Balance' requires careful pre-calculation of every loss factor to facilitate the calculation of where 'plant gain' is required, and how much 'plant gain'

SUM ALL LOSSES-

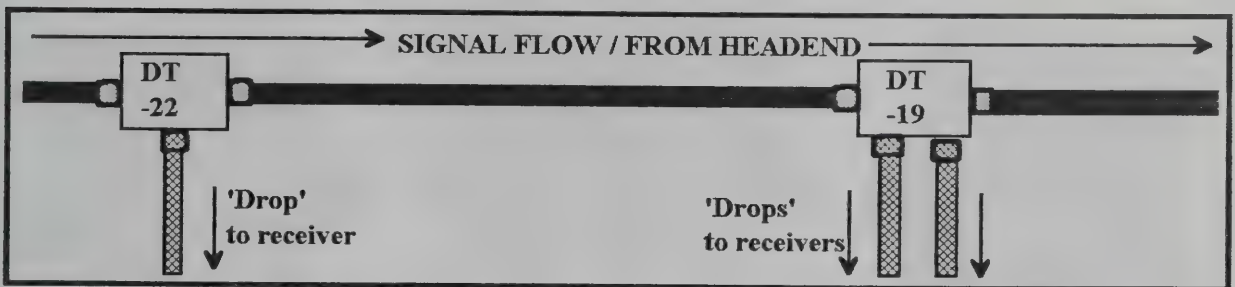
- ☐ **To calculate losses in a plant, whether in a section (portion of the whole), or longest run:**
 - Layout cable runs on scaled map, building plan
 - Place all splitters, directional couplers, directional taps on the drawing
 - Add the main-line-thru losses for each device
 - ✓ For each entry (input) and exit (output) fitting for any line device, add 0.15 dB loss
 - Resum (again) the losses including cable plus passive devices

dBs versus DOLLARS-

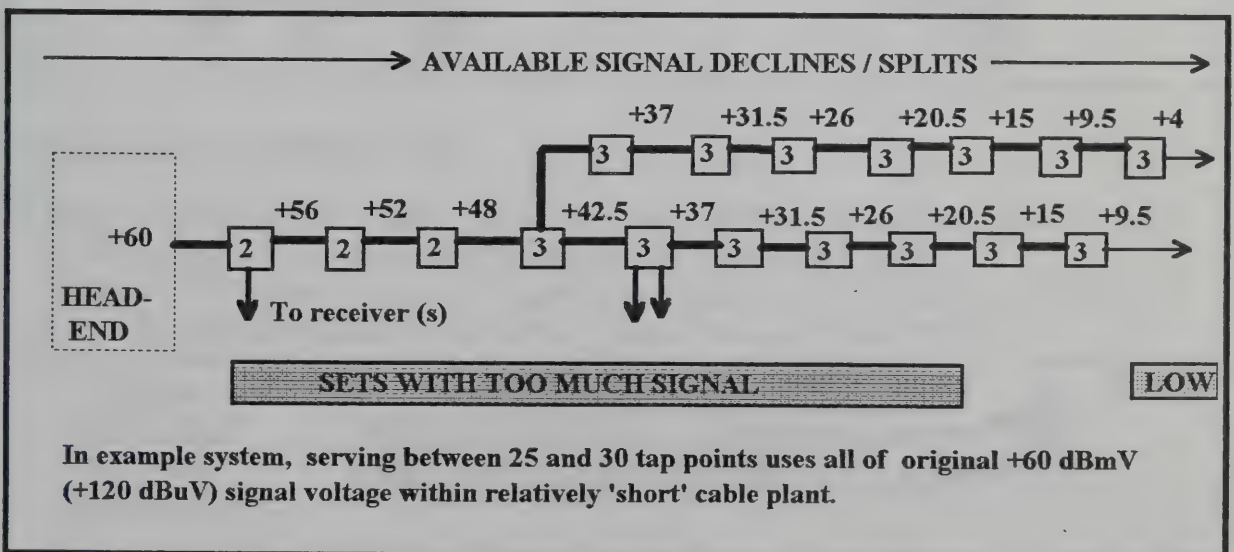
- ☐ **Except in very short systems where even using the least expensive cable you can reach the end without additional plant amplifiers:**
 - Calculate the plant at least two ways:
 - ✓ Using 'smaller' cable (with higher loss), AND, plant amplifiers
 - ✓ Using 'larger' cable (with lower loss), AND, eliminating some or all plant amplifiers
 - The best choice is the system that costs the least to install, requires least maintenance
 - Generally, amplifiers cost more than upgrading to larger cable
 - Amplifiers require powering, through the cable, or mains at each amplifier location
 - Using amplifiers brings in a new consideration; cascade-ability of amplifiers

METHODS OF REACHING INDIVIDUAL RECEIVERS-

- Headend output levels (typically +40 dBmV; +100 dBuV (+)) are too high for TV sets
 - TV sets have 'ideal input' level ranges; +6 dBmV (+66 dBuV) to +10 dBmV (+70 dBuV)
 - Levels that are too low (i.e., below 0 dBmV as a standard) produce 'grainy' (snowy) pictures
 - Levels that are too high overdrive receiver AGC functions, saturating the on-screen image
- A proper system has passive devices to connect 'measured signal amount' to each receiver
 - The most successful technique is to employ a 'directional tap' (DT) to 'measure' how much signal (voltage) goes to each receiver location
- ✓ A directional tap (DT) is a signal coupler. The main line (called trunk or feeder) plugs into the DT, the signal goes through the DT, and exits through the output side.
 - Within the DT, a capacitive network that 'couples' (taps, or extracts) a measured amount of signal out of the thru-line into the 'tap' (receiver) port



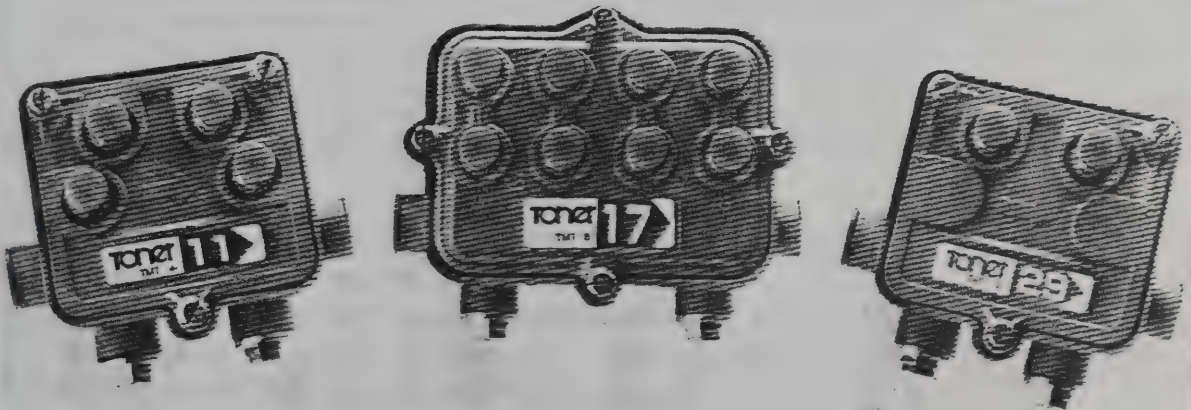
- An alternate way of dividing the signal to receivers is to use signal splitters
 - Commonly available signal splitters divide the available signal by 2 (-4dB per output), by 3 (-5.5dB per output) and 4 (-7dB per output)
 - The first TV set(s) following the headend will unfortunately receive far more signal than they need, or can properly use
- ✓ In a 'divide-down-by-splitting' system, you rapidly run out of signal at the ends as well
 - Receivers close to the headend receive too much signal, those at end too little



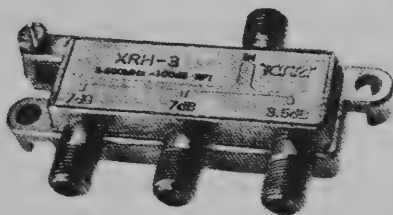
ISOLATION BETWEEN RECEIVERS-

- Individual receivers connected to the system can create interference for other receivers
 - Receiver local oscillators (LOs) appear at their own antenna input terminals
 - ✓ This LO signal must NOT be allowed to enter distribution system
 - LO signals may interfere with reception for other receivers on line
 - LO (and other receiver created signals) are isolated through tap-off devices
 - ✓ Directional taps (DTs) include 'one-way' circuits to cancel signals originating at receivers
 - ✓ Many 'splitters' have no such 'one-way' protection and thus splitter systems are more likely to experience LO interference (one TV set interfering with others)

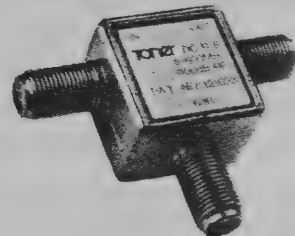
TYPICAL OUTDOOR (Weatherproof) .500, .750 DIRECTIONAL TAPS



Indoor/Outdoor Splitters



RG-59, RG-6 Indoor/Outdoor Taps



CONNECTION TO RECEIVERS-

- Every component part of cable system is designed for 75 ohm (unbalanced) impedance
 - Most modern TV receivers have 75 ohm (coaxial F connector) inputs
 - Those with 300 ohm balanced line inputs must be 'matched' to 75 ohm system impedance
 - ✓ A 'Matching Transformer' is required; 75 ohm 'input', 300 ohm 'output'

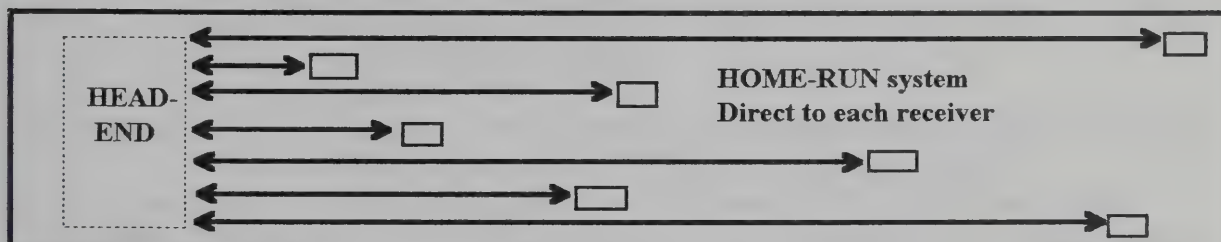
Typical
75/300 ohm
matching
transformer



VARIATIONS IN SYSTEM DESIGN-

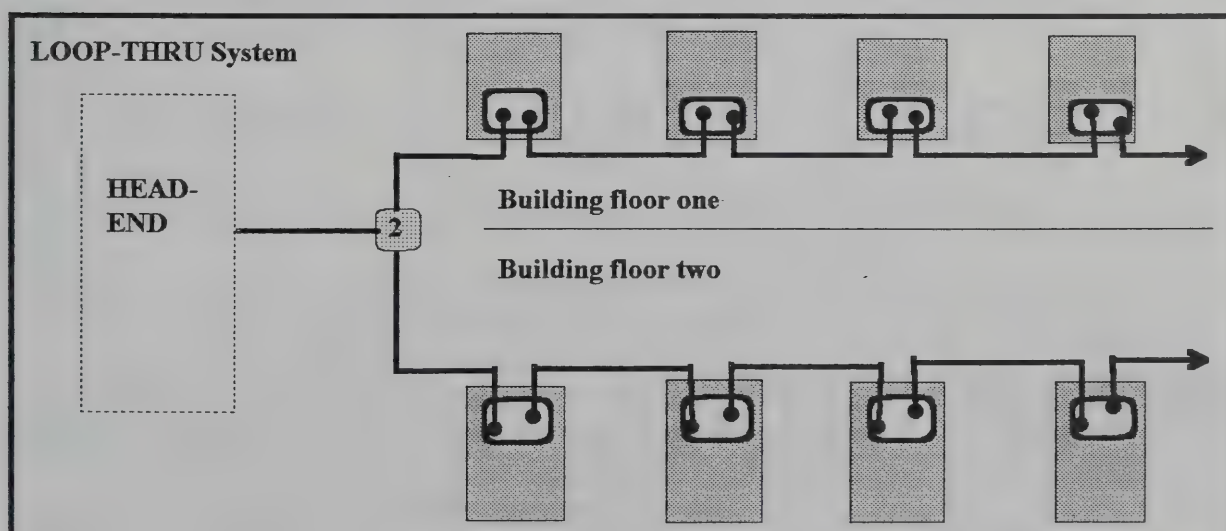
☐ Home-run system wiring

- Each receiver outlet is directly connected to headend
 - ✓ Advantage: Allows central connection, disconnection
 - ✓ Advantage: Allows two-way communication on dedicated line
 - ✓ Advantage: Allows custom programming feeds to individual receivers
 - ✓ Disadvantage: Very expensive since each outlet requires own, dedicated coaxial line
 - Seldom used except in concentrated hotel/motel/apartment installations



☐ Looped system wiring

- Variation of directional tap system without advantages of 'DT' isolation
- Single floor, 'single-riser' runs loop from outlet to outlet
 - ✓ Advantage: Tap-off device built into wall plate box, eliminates need for separate 'DT'
 - ✓ Advantage: Eliminates minimum of 3 'connectors' associated with each receiver outlet
 - ✓ Advantage: Typically less costly than DT system
 - ✓ Disadvantage: Greatly reduced (if any) isolation for individual receivers
 - ✓ Disadvantage: Signal tap for each room is 'in open' subject to corrosion, failures
 - ✓ Disadvantage: Failure any loop-thru-tap interrupts service at all outlets beyond that point
 - ✓ Disadvantage: Bandwidth restricted, often limited to bands I and III only
 - Loop-thru systems are usually installed by 'low-priced-bidders' who obtain contract on price, not system performance and as a part of being low in price, the choice of coaxial cable type often is also very poor and amplifiers, if required, usually not of best quality



COMPENSATING FOR UNEVEN CABLE LOSSES-

☐ Cable losses vary with the operating frequency

- Losses at 230 MHz are 1.94 times greater than at 55 MHz
- Two modulators, one at 55 MHz and the other at 230 MHz:
 - ✓ after 100 metres of cable, 230 MHz will be only 40.5% as strong as 55 MHz
 - for RG-6/U cable:
 - after 100 metres, 55 MHz will be 4.14 dB stronger than 230 MHz
 - after 200 metres, 8.28 dB stronger
 - after 300 metres, 12.42 dB stronger
 - after 400 metres, 16.56 dB stronger
 - after 500 metres, 20.7 dB stronger

☐ The DIFFERENCE in losses between the lowest frequency carried (55 MHz) and the highest frequency carried (230 MHz) is termed TILT LOSS

- In a system with only headend amplifiers (no cable plant amplifiers), tilt loss must be equalised (corrected) to ensure receivers connected do not experience wide differences in reception quality between low end (55 MHz) and high end (230 MHz) TV channels
 - In a system with plant amplifiers, input levels to plant amplifiers must be FLAT (lowest channel same as highest channel) to ensure proper amplifier operation

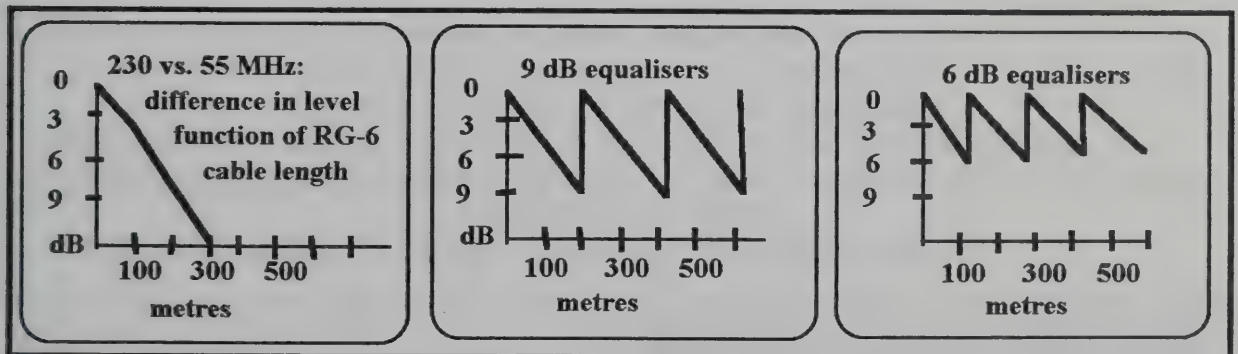
☐ Tilt can be calculated in advance; a known amount of cable using known lowest and highest frequencies will produce 'X.X' dB of tilt at the end of the cable

- When the tilt is known (calculated or measured) it can be compensated

✓ Compensation: Turn headend output levels UP on higher channels, down on lower channels

✓ Compensation: Passive 'equaliser' placed within system to re-balance levels

- Passive equaliser: frequency selective attenuator, reduces lower frequencies more, higher frequencies less (or not at all)

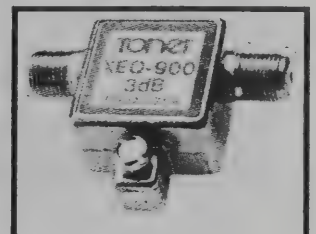


☐ Passive equalisers are placed in cable (trunk) line wherever the balance between low and high frequencies exceeds an acceptable level

- Equalisers are frequency-designed (5-600 MHz, 50-300 MHz etc.)
- Equalisers are 'dB correction' designed (3 dB, 6 dB, 9 dB etc.)

☐ Passive equalisers can also be used for individual receiver 'drops'

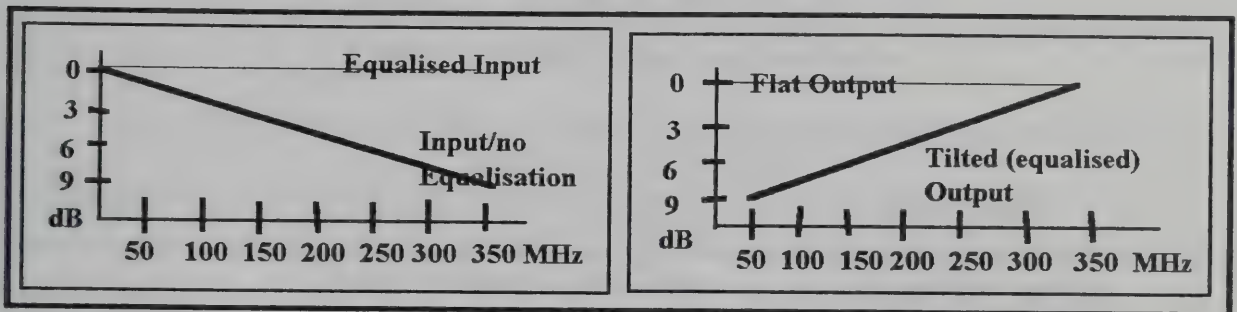
- Restores 'balance' between low and high frequencies at end of 'drop' (Typical 'F-fitting' grade equaliser: right)



BALANCING AMPLIFIER INPUTS / OUTPUTS-

☐ Rule of thumb: Enter plant line amplifiers 'flat', leave 'tilted'

- Amplifiers not only amplify, they also generate undesirable 'trash' products
 - ✓ '2nd Order' (harmonic) products
 - ✓ '3rd Order' (beat) products
- The quality of an amplifier's output depends upon a rejection of 2nd and 3rd order products
 - ✓ 2nd and 3rd order products create 'beats' or 'interference' for amplified signals
 - ✓ Each successive amplifier increases 2nd and 3rd order products
 - As more and more amplifiers are used in series (cascade), the greater the products
 - At some point (number amplifiers) the products create significant degradation to pictures and cable system quality becomes unacceptable
- 2nd/3rd order 'trash' products are minimised when:
 - ✓ Amplifiers are operated 'flat', i.e., equal gain for the full spectrum

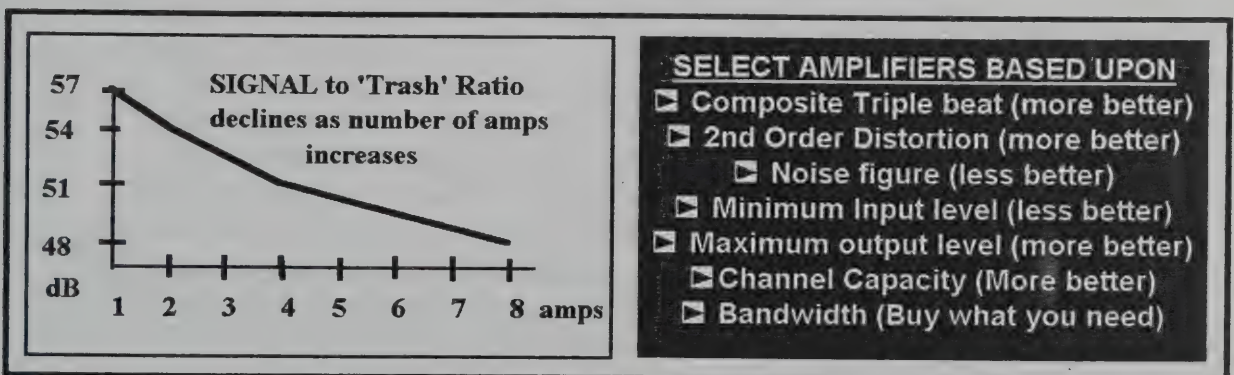


- ✓ Active amplifier stages operate 'flat', i.e., equal gain all frequencies
- ✓ Passive equalisation 'tilts' output AFTER amplifier output before signal re-enters cable

CASCADING AMPLIFIERS-

☐ Two or more amplifiers connected 'in series' are operating 'in cascade'

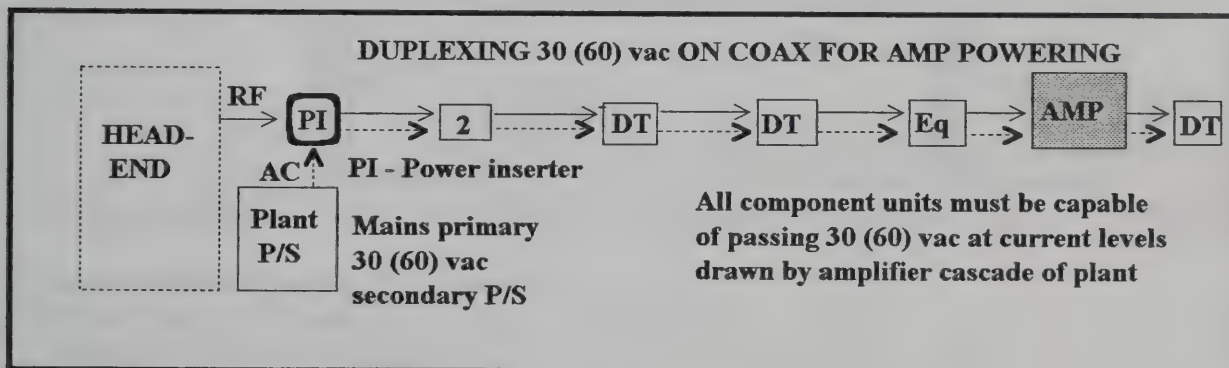
- Amplifiers are rated by their 'Cascade-Ability'; how many amplifiers of the same type can operate 'in series' without objectionable degradation?
- Each individual amplifier adds distortion, beat-products, 'trash' to the amplified signals
 - Typically, each time the number of amplifiers 'in series' (cascade) doubles, the objectional 'trash' doubles in strength
- With each 'doubling' of 'trash' the margin (signal to trash ratio) reduces



POWERING IN-PLANT AMPLIFIERS

☐ In-plant amplifiers must be powered to operate

- Power can come from mains (connect 230vac amplifier p/s to mains at each amp location)
- Power can be fed to amplifier through coaxial cable 'trunk'
 - ✓ Plant amplifiers designed to be cable-powered:
 - Typically operate from 30 to 60 VAC sources
 - Actual amplifier operating voltage typically 18-21 vac
 - DC voltage is NOT used because of electrolysis (corrosive build up) at high current points (the lead-acid auto battery 'effect')
 - Typical plant amplifiers require 250 to 500 mA of 30 to 60 vac current
- When AC power is duplexed onto the coaxial cable for plant-amplifiers:
 - ✓ All in-line components (splitters, directional taps, equalisers etc.) must have an AC power passing capability
 - The current that will pass through any in-line device must not exceed the current passing capability of the component unit
- 30 - 60 VAC voltage fed through coaxial cable originates in mains primary/30 (60) vac transformer power supply
- Within each amplifier, the 30 (60) vac is converted to DC for amplifier operation



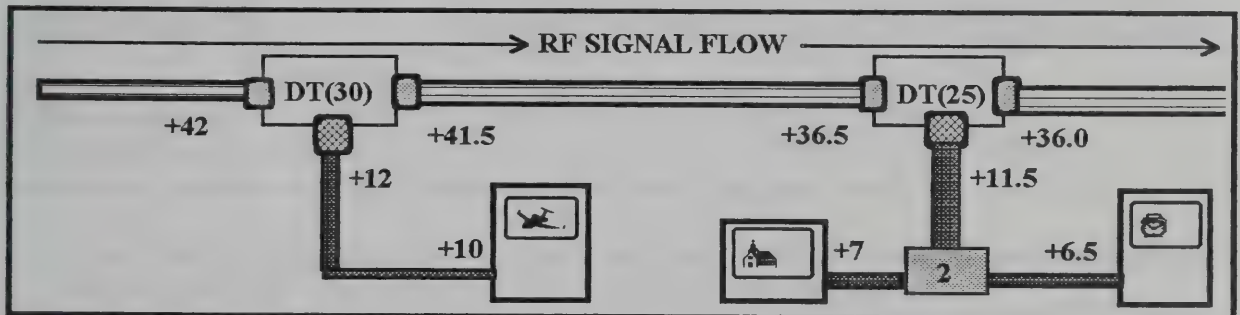
PROTECTING AGAINST CABLE / SYSTEM DAMAGE-

☐ Neither VHF 'RF' nor 30 (60) vac like intrusion of 'foreign elements'

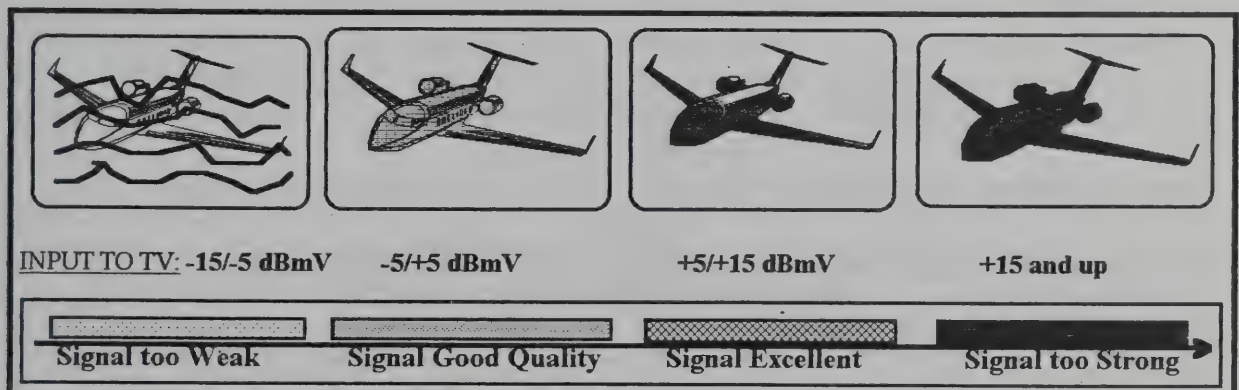
- Cables must NOT be bent (curved) or crimped such that their outer shield is 'creased'
 - ✓ A 'creased' cable can:
 - Allow ingress of outside radio spectrum signals
 - Allow egress of cable plant signals to outside world ('radiation')
 - Allow moisture to penetrate cable causing signal degradation, AC powering 'shorts'
 - Set up 'standing waves' that 'trap-out' (selectively attenuate) certain frequencies
- Do not use nails (bent over) or hammer-driven staples to attach cables to support members
 - ✓ 'Crimping' coaxial cable is a bad mistake
 - ✓ Multiple, randomly spaced, crimps cause 'suck-outs' of unpredictable frequency groups
- Seal ALL connections with an approved Silicone seal to prevent moisture seepage

CALCULATING TAP VALUES-

- ☐ Goal of each 'DT' (directional tap, signal tap-off device) is to supply proper amount of signal to each receiver in system
- ☐ Because you know (from measurements) the signal level leaving the headend;
 - Because you can calculate the signal losses from the headend to each 'DT'; location:
 - ✓ Subtract cable losses to that point (so many dB per 100 metres or fraction of 100m)
 - ✓ Subtract losses in passive devices (splitters, other DTs, connectors, etc.) between headend and the DT point
 - You can calculate the actual 'line level' for each DT location in advance, on paper
- ☐ DTs are available in various 'isolation values'
 - Isolation value (a dB number) describes "How many dB BELOW the line level the signal will be out of the DT receiver port"
 - ✓ EXAMPLE: a 20 dB 'Tap' (DT) will produce a signal to the receiver that is 20 dB less-than (i.e., -20 dB) the thru-line signal to the DT
 - If the calculated line level is +42 dBmV (+102 dBuV) at a point, and you install a 30 dB value DT, the actual signal level leaving the DT receiver port will be $42 - 30$ or (+)12 dBmV / +72 dBuV



- ☐ The actual signal level to the receiver is:
 - Line level at DT location
 - Minus 'isolation value' of DT
 - Minus any additional cable losses to receiver
 - Minus any losses from in-house splitters
 - ✓ DT 'value' is adjusted for any outlet requiring splitters, or requiring long (signal lossy) runs



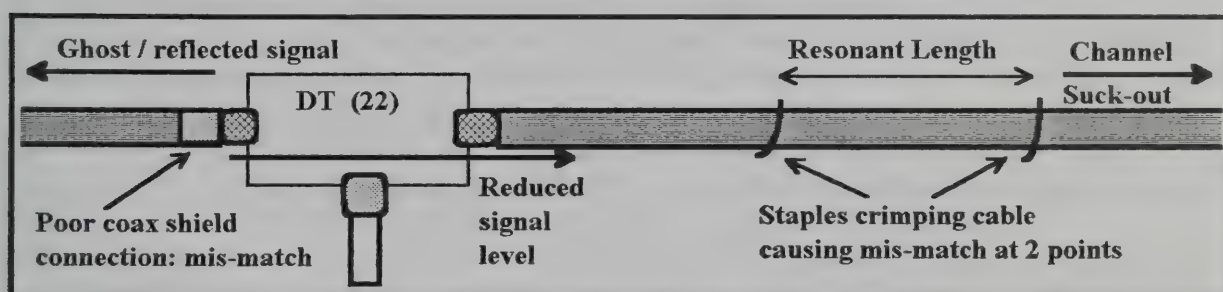
MATCH, MIS-MATCH and FITTINGS-

☐ Cable system reception quality depends upon:

- The signal to noise ratio of each channel as measured at the headend
- The signal (voltage) level as delivered to each receiver, on each channel
- The signal to 'trash' ratio between desired signals and non-desired system generated 'trash' as measured at each receiver (drop) location
- The integrity of the system operating impedance (75 ohms, unbalanced) starting at the headend and ending at the receiver input

✓ Operating impedance integrity is called 'match'

- Within the system, the operating impedance is established by the cable selected
 - All non-cable parts must 'match' (have the same impedance as) the cable
- Variations in 'match' are quantified by measurement of 'mis-match'
 - Any mis-matched component creates system loss at the point of mis-match
 - Mis-match points in the system cause visible degradation known as 'ghosts'



☐ When shield-side of coax is not properly connected to DT a significant mis-match occurs

- Mis-match causes some signal energy to be lost at the connector
- Mis-match leaves the lost energy with no place to go except 'backwards' towards the source

✓ This reverse-flow causes 'ghosts' on the receivers in the affected area since they now receive two signals for each channel: the forward direction strong signal, the reverse direction, weaker, reflected signal

- Ghost images typically follow (on the right hand side of) the primary signal
- The major effect of ghosts is a blurring of images, the loss of 'sharp, distinct edges' on video images (edges soften, blend into the next object to right on screen)
 - Significant mis-match causes double (ghost) images on screen

☐ Crimping of cable causes a change in the cable's impedance at the point of 'crimp'

- Two or more (multiple) crimps caused by multiple staples that have been poorly installed

✓ The electrical distance between staples ('crimps') establishes a 'resonant line section'

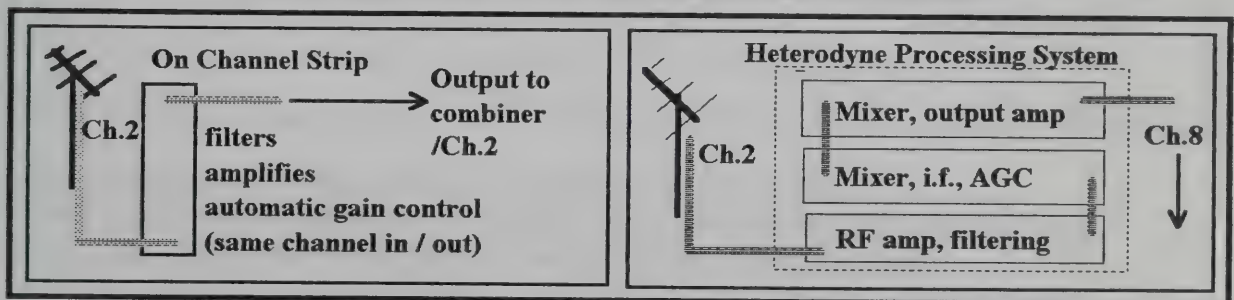
- At some TV channel wavelength within the cable spectrum, the resonant line will become a 'signal trap'
- At this frequency, on this channel, one (or two) channels will attenuate (reduce in level)
 - At all points AFTER this resonant length, this channel(s) will unexplainably be weaker than the others on the system

YOUR CHANNEL INVENTORY-

- ☐ Your cable spectrum (such as 50-450 MHz) is your 'inventory'
- ☐ Within the inventory are at least two 'classes' of product:
 - Local (terrestrial) signals, received direct or via satellite 'relay'
 - ✓ The 'value' of this inventory will differ from your non-local signals
 - Satellite delivered programming channels
 - ✓ Within the 'satellite class' of channels may be two or more additional 'sub-classes'
 - Advertising supported 'free to air' programme channels
 - Premium channels (which may or maynot include advertising; ESPN, for example)
- ☐ Traditionally, 'local channels' capture upwards 60% of viewer's attention (viewing time)
- ☐ Satellite-only channels, however, offer programming options not otherwise available and account for 90% of the interest in being a part of a SMATV/CATV system

Creating Channel Schemes-

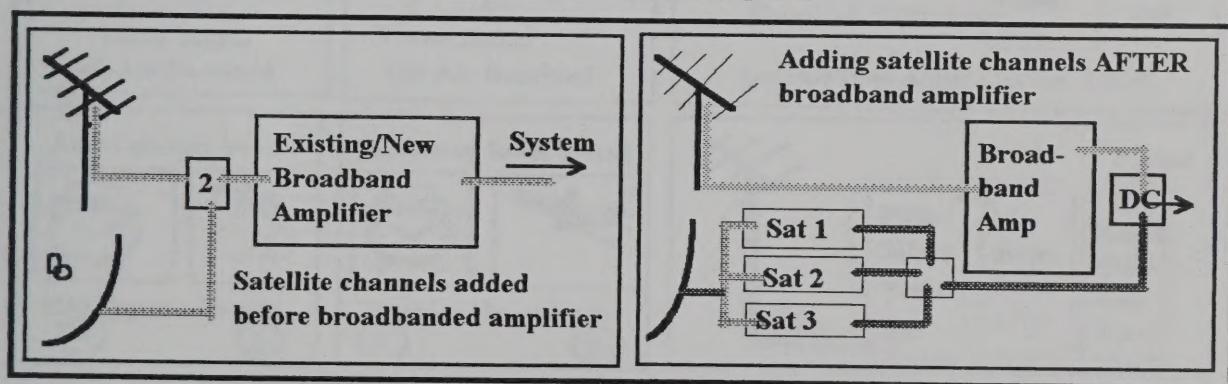
- ☐ Local channels may be best retained on their as-received channel
 - If the cable system is within the very strong signal area of a local channel, the channel may be moved to a new dial position to avoid direct-pick-up ghosting
 - ✓ Local channels are placed on the cable after 'processing'
 - 'Processing' involves filtering (to eliminate interference), amplification, AGC
 - During processing, the signal level of the aural carrier is adjusted (downward) to allow operation in an 'adjacent-channel' (stacked channel) format
 - Processing can be done 'on channel' with 'strip amplifiers' (single channel amplifiers)
 - Processing on channel, or, by moving a channel as received off-air to a new channel, is done with 'heterodyne signal processors'
 - ✓ Heterodyne channel processors receive any VHF / UHF channel, reduce it to an i.f. range, reconvert from i.f. back to a (system chosen) output channel



- ☐ Channel grouping by interest areas is often employed
 - If your local channels can be grouped (using heterodyne processors to new channels):
 - ✓ If the local networks are widely known by their channel or service numbers, try to make their dial position correspond to their on-air identification numbers
 - ✓ If this results in 'empty dial positions' between channels, do not group the more popular satellite channels together; spread them out on the dial
 - This forces more frequent 'Channel Surfing', which adds to the perceived value of the cable service (viewers are forced to confront and evaluate different channel offerings each time they change channels)

ADDING (new) SATELLITE CHANNELS TO EXISTING SYSTEMS-

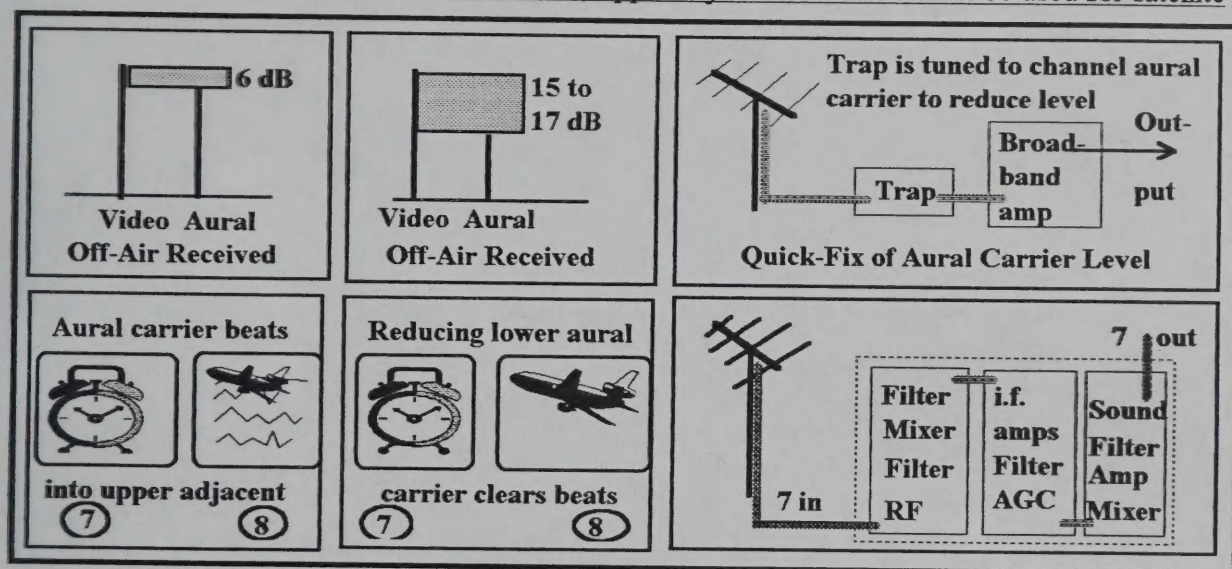
- Satellite channels may be added to existing MATV systems; with caution -
 - If MATV systems place local, terrestrial signals onto cable withOUT using strip or heterodyne processing, do not use 'adjacent channels' for satellite programming
 - ✓ Lacking processing, the local signals will interfere with new adjacent channel satellite signals
 - Local channel sound carriers, as a minimum step, must be 'turned down'
 - If MATV system uses broadbanded amplifier for gain:
 - ✓ Will the existing amplifier carry additional satellite channels without overloading?
 - If MATV system uses in-plant (line) amplifiers, will they accept additional carriers without overload, degradation?
 - What is quality of reception at various existing outlets? Does system need repair?
- Adding channels from satellite must be done such that when entering the system these new channels will 'match' the signal voltage level of existing terrestrial channels
 - If the MATV system has only a single (headend) broadbanded amplifier, and this amplifier cannot accept the new satellite channels:
 - ✓ Satellite channels from their respective modulators can be combined as a sub-group
 - ✓ The satellite sub-group is added to system through (DC) directional coupler AFTER the existing broadbanded amplifier



- To ensure the blend of terrestrial and satellite mixes well together:
 - Select frequency assignments for satellite that avoid conflicts with terrestrial channels
 - ✓ Avoid channels in use in your region, not just your immediate area
 - ✓ Avoid channels which may have conflicts from 2-way and FM broadcast radio
 - ✓ Avoid channels one-up from terrestrial signals unless you will process the local channel by turning 'down' its aural carrier level
 - Add the satellite channel to the system without overdriving MATV system amplifiers
 - ✓ Where required, replace existing limited-capacity amplifiers with new high capacity units
 - ✓ In systems with in-plant line amplifiers, verify their ability to handle additional channels
 - Before adding new channels, check present reception at all cable-leg ends to verify existing system performance
 - ✓ Adding new channels won't affect system taps (passives) but may present opportunity to have existing problems repaired

STEPS TO SET-UP NEW CHANNELS-

- ☐ Select appropriate frequency for new channel
 - Choice of:
 - ✓ Factory-assigned, as-built modulator frequency (i.e., pre-channelised)
 - ✓ Frequency-agile modulators (i.e., any channel from 50 to 450/550 MHz; field set up)
- ☐ Determine how new channel(s) will fit into total channel plan
 - Possible upgrade of existing channels in system at same time
 - ✓ Replace existing all-channel broadbanded amplifier(s) with individual channel processing at headend
 - ✓ At very least, install tuneable sound carrier trap on terrestrial channels to set audio down 15 to 17 dB reference visual carrier
 - By controlling a channel's sound carrier, you open up use of the next upper (adjacent) channel for use by a satellite service
 - Without sound carrier control, upper adjacent channel cannot be used for satellite



- ☐ Carefully select combining hardware to add new service(s) to existing system
 - (Hybrid) splitters are a poor second choice for combining channels; directional couplers offer better isolation between sources, better operation
- ☐ After combining satellite modulators to existing system:
 - Adjust video modulation following instructions for no more than 87.5% modulation peaks
 - ✓ Carefully monitor during regular programming for minimum of 15 minutes to ensure modulation does not exceed set-level on 'peaks'
 - Adjust aural modulation following instructions and monitor for at least 15 minutes
 - ✓ If aural modulation sounds 'confined', re-check impedance matching between satellite receiver and modulator input
 - Verify the quality of the new channel by inspecting the reception on a number of receivers, preferably varying brands and models
- ☐ NEVER select 'double sideband' modulators for satellite channels

